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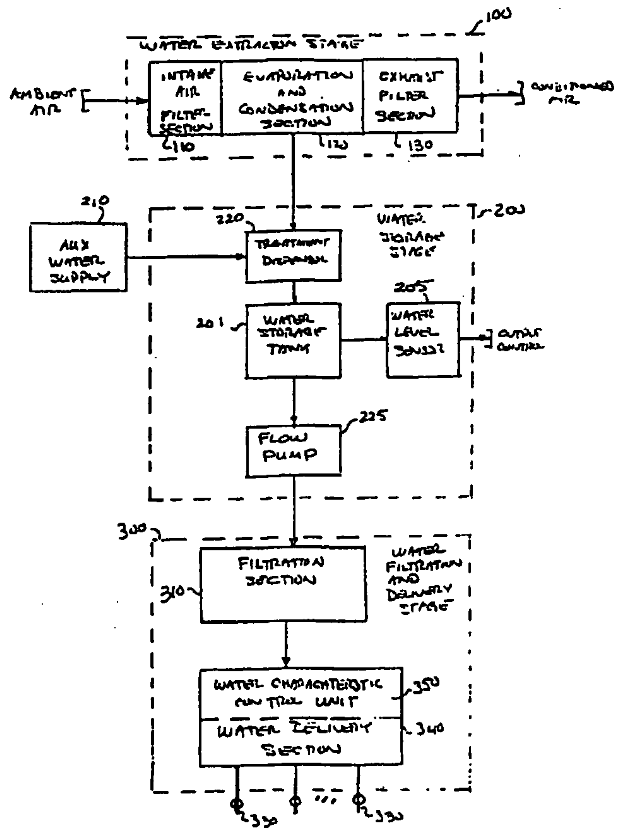
(57) Abstract

A purified water supply apparatus comprises a sealed water extraction stage (100) that is operative to draw in, filter and extract water vapor from ambient air, and to filter the processed air before being returned to the surrounding environment. A sealed water storage stage (200) chemically treats and stores water that has been condensed out of the filtered ambient air by the water extraction stage (100). A water filtration stage (300) is installed in a sealed water flow path through a water flow control mechanism coupled to the water storage stage, the water filtration stage containing a plurality of filters that are effective to filter out particulates, dissolved chemicals and biological contaminants from water pumped by a water pump (225) from the water storage stage (200) for delivery to a filtered water dispensing unit (340) that provides, stores and dispenses potable drinking water in different forms which include room temperature, hot, cold, carbonated and solid (ice) and can dispense a carbonated and flavored soft drink.



# PURIFIED WATER SUPPLY APPARATUS

## CROSS-REFERENCE TO RELATED APPLICATIONS

The present application claims the benefit of previously filed co-pending U.S. Provisional Patent Application, Serial No. 60/026,342, filed September 19, 1996.

## FIELD OF THE INVENTION

The present invention relates to water supply apparatus, and is particularly directed to a relatively compact, portable apparatus, the internal components of which are sealed from the surrounding atmosphere, for extracting water from water vapor in prefiltered ambient air, and then treating, storing, filtering and dispensing purified water in multiple phases, by a water recovery scheme that also improves the quality of the air returned to the environment through a process of dehumidification, cooling and filtration.

## BACKGROUND OF THE INVENTION

Although a variety of water extraction and treatment systems have been proposed to date for recovering potable water from the water vapor present in the ambient air, each has its own shortcomings, either from a standpoint of complexity and energy required (including heat dissipated into the atmosphere), or its failure to take into account a number of contaminant parameters that may be present in the air or in the water being made available for human consumption. While many of these systems are touted as portable, their operation and the quality of the water produced by the extraction process is often dependent upon the environment in which they operate.

For example, while a number of systems are condensation-based, the water recovery path to post extraction storage and treatment components may be exposed to the environment and thereby allow entry of

contaminants. In addition, many systems are not readily suited for indoor use, for example due to their size or their negative impact on the closed environment (e.g., heating/recirculation of contaminants).

SUMMARY OF THE INVENTION

In accordance with the present invention, these and other shortcomings of conventional water supply systems, including portable extraction systems intended for indoor use, are remedied by what is effectively an environmentally friendly water extraction apparatus, that not only provides highly purified water, but also improves the quality of the ambient air from which the water is being extracted prior to returning the air to the surrounding environment.

For this purpose, the present invention comprises an integrated arrangement of a water extraction stage, a water storage/reservoir stage and a water filtration and delivery stage. The entirety of the air and water processing paths through the integrated multistage system is sealed from the surrounding environment, so as to prevent entry of contaminants into any part of the system and thereby ensure purity of the water. This sealed configuration of the water extraction, storage and delivery components of the present invention enables the invention to be utilized in substantially any environment, including those containing substantial amounts of industrial, agricultural, biological, chemical and other forms of pollutants.

The water extraction stage is operative to draw in and filter ambient air, and then extract water vapor from the ambient air. Once the drawn-in ambient air has been dehumidified by the water extraction process, it is then subjected to further cooling, so that the air returned to the environment is not warmer than the ambient, making the system especially user friendly in an indoor environment. In addition, the dehumidified air is again filtered in an exhaust air filtration section before being returned to the surrounding environment.

The water extraction stage resides in a sealed housing, so as to prevent leaks between the external ambient and the interior of the entire water extraction subsystem contained therein. This effectively eliminates any chance of unfiltered air or other contaminants from entering components of any of the water extraction stage, as well as downstream water storage, purification and delivery subsystems.

By means of a forced air unit, ambient air is drawn through an air inlet port to an intake air filter section that preferably includes a cascaded arrangement of a passive, large particle filter and an active, small particle (electrostatic) filter. These filters serve to filter the intake air of all dust or mold or any unwanted air-borne particles. The filtered intake air is then drawn through a water extraction (evaporation and condensation) section, which contains a two-stage evaporator and condenser coil arrangement, that condenses water from water vapor in the filtered intake air, and cools the air, prior to its being returned to the surrounding environment. De-icing heater elements prevent freezing of the evaporator coils, when the unit is operating in temperatures below sixty five degrees Fahrenheit.

The forced air unit is controlled in accordance with the output of a high level sensor within a water level sensor unit installed in an insulated storage tank of the water storage/reservoir stage. The forced air unit is activated (drawing air into the system), as long as the high water level sensor element detects that the water within the storage tank is below a prescribed 'high' level (i.e. the water storage tank is less than full). As condensed water is collected, it is channeled through a sealed water collection conduit to the water storage/reservoir stage. When the water level sensor detects that the storage tank is full, the various powered components of the water extraction section are turned off.

A sealed air recirculation duct, containing a recirculation fan, is coupled to recirculate air that has been processed through the water extraction components of the water extraction section, so as to provide for removal of as much water vapor as possible from the filtered air, which is somewhat cooled so as to prevent warm air from being returned to the surrounding environment. An exhaust air filter is installed adjacent to an exhaust port, to prevent any contaminants that might possibly be present in the processed air from being injected back into the atmosphere.

The water storage/reservoir stage includes a sealed and insulated water storage tank that chemically treats (disinfects) and stores water that has been condensed out of the filtered ambient air by the water extraction stage. This dissolved biological contaminant treatment material is subsequently removed by filtration components of a water filtration and delivery stage. The water storage tank is also ported to an auxiliary water supply, so that it may filled from a source other than the water extraction stage.

The ability to store and process water from an auxiliary source accommodates the situation, where the water vapor content in ambient air is insufficient to meet user demand. A control valve may be provided in the auxiliary water supply line from the auxiliary water supply source for enabling water to be automatically supplied to the storage tank when the water level in the water storage tank drops to a low level, as detected by a low water level sensor.

The purified water delivery section comprises a multistage water filtration section installed in a sealed water flow path through a water flow control pump that is coupled to the output of the water storage tank. By means of a series of progressively finer porosity filters, the water filtration section filters out (absorbs/blocks) substantially all particulates, as well as dissolved chemicals and biological contaminants from the treated

water, as it is being pumped from the reservoir stage for delivery to one or more water outlet valves of the purified water delivery section.

The water filtration section is also effective to adjust the pH of the water, and thereby compensate for the very low pH in the water that has been collected and stored in the water storage tank, and to sterilize the water, killing bacteria, viruses and other microorganisms, removing large particles of sediment, rust, dirt and sand, absorb halogens (e.g., chlorine, iodine, bromides and the like) and other contaminants, eliminating industrial and agricultural residual chemical compounds, as well as herbicides, pesticides, industrial and commercial cleaners and other Trihalomethanes (THMs).

As water is pumped through and filtered by the multistage filtration section, it is monitored via a flow meter. When the water treatment system has reached a maximum gallon usage (at which time the water filters require replacement), the flow meter generates an output signal that shuts down the water pump, and thereby prevents the flow of water through the water flow path to the purified water delivery section.

The purified water delivery section supplies purified water on demand by way of one or more output valves of a multitap water dispensing system. This water dispensing system includes respective supply paths to a mixing valve, a water heater, a water cooler, a direct feed output valve, and a supply valve of an ice-maker. The mixing valve may be coupled to a carbonation tank and to a flavoring additive supply tank, which stores a flavoring additive, such as a flavored soft drink syrup. This mixing arrangement allows the water to be mixed with additives (e.g., flavoring and/or carbonation), as desired, to produce a self-generated carbonated and flavored soft drink.

Electrical power for operating the water extraction and purification system of the present invention may be derived from a conventional AC source, such as 110 VAC. In addition, auxiliary power may be supplied by a number of sources, including a commercially available twelve volt direct current wind-driven generator, and a commercially available twelve volt direct current photoelectric solar array, connected via a switch to a twelve volt direct current storage battery. Also, an auxiliary emergency battery back-up trickle charge circuit may be coupled with the switch to selectively provide a trickle charge to the battery. The trickle charger keeps the twelve volt direct current storage battery fully charged, so that the battery can be used to power the water pump via the direct current-to-alternating current converter.

The storage battery can maintain a full charge, so as to enable the water pump and low wattage lighting elements, associated with the output taps of the water dispenser, to be operated, without conventional power. Thus, in the event of a power outage, the auxiliary power supply will at least power those components that will allow the user to be supplied with whatever water is in the water storage tank.

<u>BRIEF DESCRIPTION OF THE DRAWINGS</u>

Figure 1 diagrammatically illustrates the functional architecture of a sealed, purified water supply apparatus in accordance with an embodiment of the present invention;

Figure 2 diagrammatically illustrates the manner in which the components of the respective stages of Figure 1 may be integrated within a relatively space efficient structure;

Figure 3 shows the details of the water extraction stage 100 of the apparatus of Figures 1 and 2;

Figure 4 shows the details of the water storage/reservoir stage 200 of the apparatus of Figures 1 and 2;

Figure 5 shows the details of the water filtration and delivery stage 300 of the apparatus of Figures 1 and 2; and

Figure 6 diagrammatically illustrates sources of electrical power for operating the water extraction and purification system of the present invention.

DETAILED DESCRIPTION

An embodiment of the purified water supply apparatus of the present invention will now be described with reference to Figures 1-6. The overall functional architecture of the invention is shown in Figure 1, while Figure 2 diagrammatically illustrates the manner in which the components of the respective air and water processing stages of Figure 1, shown in detail in Figures 3-5, may be integrated within a relatively space efficient structure, that may be either portable (roller-mounted) or stationary (cabinet mounted).

As shown in the Figures, the invention comprises a sealed, integrated arrangement of a water extraction stage 100, a water storage or reservoir stage 200 and a multistage water filtration and delivery stage 300. The water extraction stage 100 (shown in detail in Figure 3, to be described) is operative to draw in ambient air, and extract therefrom water vapor present in the air as the air passes through an intake air filter section 110. The air flow path through the intake air filter section 110 is relatively 'upstream' of a water evaporation and condensation section 120. Once drawn-in ambient air has been dehumidified and somewhat cooled by the water extraction stage, it is again filtered in an exhaust air filtration section 130 before being returned to the surrounding environment.

The water storage/reservoir stage 200 (shown in detail in Figure 4, to be described) includes a sealed and insulated water storage tank 201. Storage tank 201 is coupled to the water extraction stage 100 by means of a sealed conduit, so as to prevent entry of any contaminants

into the collected water flow path to the tank. Tank 201 treats and stores water that has been extracted or condensed out of the filtered ambient air by the water evaporation and condensation section 120 of the water extraction stage 100.

The reservoir tank 201 is also ported to an auxiliary water supply 210, so that it may store water that is suppliable from a source other than the water extraction stage 100. As water is introduced into the storage tank 201, it is treated by means of a water treatment chemical dispenser 220, which dispenses a measured amount biological contaminant treatment material, such as a halogen (e.g., chlorine or bromine, as non-limiting examples) into the water stored in the tank. (This biological contaminant treatment material is subsequently removed by filtration components of the water filtration and delivery stage 300.)

The storage tank 201 of the reservoir stage 200 also contains a water level sensor unit 205, containing respective high and low level sensors. The water level sensor unit 205 is operative to control the operation of a water flow pump 225 installed in a downstream sealed water flow path 230 to the multistage water filtration and delivery unit 300, in accordance with the volume of water in the reservoir.

The multistage water filtration and delivery stage 300 (shown in detail in Figure 5, to be described) includes a water purification/filtration section 310 containing a sequential arrangement of filters. These filters filter out (absorb/block) particulates and chemical and biological contaminants from water being pumped out of the tank 201 for delivery to one or more water outlet ports 330 of a purified water delivery section 340. The purified water delivery section 340 is configured to not only directly deliver purified water at room temperature as it is pumped out of the tank 201 and then filtered by the filtration

section 310, but contains a water characteristic control unit 350 installed between the output of the water filtration section 310 and the water outlet ports 330.

The water characteristic control unit 350 is operative to control at least one characteristic of the water as it is supplied to the user. As a non-limiting example, the water characteristic control unit 350 may control at least one of the temperature/phase of the water (e.g., provide hot water, cold water and ice) and the introduction of a substance (e.g., flavoring, carbonation and the like) into the purified water.

Referring now to Figure 3, the water extraction stage 100 is shown as comprising a sealed housing 101, having an air inlet port 103 through which ambient air enters stage 100. Because the housing 101 is sealed, there are no leaks between the external ambient and the interior of the entire air intake, water extraction and air exhaust system contained therein. This effectively eliminates any chance of unfiltered air or other contaminants, such as unwanted foreign airborne, insects, or animal/insect debris from entering the water extraction, storage and purification and delivery subsystem components.

The air inlet port 103 is in fluid communication with the intake air filter section 110 installed in an air intake chamber 111, through which all air entering the stage must pass. The intake air filter section 110 includes at least one and preferably a cascaded arrangement of increasingly finer porosity intake air filters, such as a passive, large particle filter 113 and an active, electrostatic small particle filter 115 located downstream thereof. Intake air filters 113 and 115 may comprise commercially available filters, obtainable from Airhandlers Corp., as a non-limiting example. These filters serve to filter the intake air of all dust or mold or any unwanted air-borne particles.

Coupled in the intake airflow path immediately downstream of the intake air filter section 110 is the water evaporation and condensation section 120. As described briefly above, the water evaporation and condensation section 120 contains at least one water extraction element that is operative to extract water vapor present in the intake air that has passed through the intake air filter section 110, upstream thereof.

For this purpose, an upstream end 121 of water evaporation and condensation section 120 contains a first or primary refrigeration evaporator coil 122, which is supplied with refrigerant from a compressor unit 123. As will be described this first, as well as a downstream second evaporator coil, in combination with a pair of condenser coils, perform a two stage process of water extraction and cooling of the exhaust air being returned to the surrounding environment.

This first evaporator coil 122 is operative to condense water vapor present in the filtered intake air as the air passes over the coil. As a non-limiting example, this and a further evaporator coil, as well as condenser coils and associated compressor units employed in the invention may comprise commercially available components, obtainable from Emerson Electric Corp., as a non-limiting example. In order prevent corrosion and extend the life of the evaporator and condenser coils, it is preferred that the coils be externally coated (for example, by spray or brush application) with a corrosion prevention material, such as titanium oxide, as a non-limiting example. Associated with primary evaporator coil 122 is a de-icing heater element 122H, which is controllably operative to prevent freezing of the evaporator coil, when the unit is operating in temperatures below sixty five (65) degrees Fahrenheit.

Also installed in the water evaporation and condensation section 120, downstream of evaporator coil 122, is a forced air unit/fan assembly 124, which is

controllably operative to draw ambient air into the system. The operation of the fan assembly 124 is controlled in accordance with the output of a high level sensor within the water level sensor unit 205 installed in the storage tank 201 of the water storage reservoir stage 200. In particular, the fan assembly 124 is activated to draw air into the system, as long as the high water level sensor element detects that the quantity or volume of water within the storage tank 201 is below a prescribed 'full' or 'high' level. However, when the high level sensor detects that the storage tank 201 is full, the various powered components of the water extraction section 120, including the compressors of the evaporator and condenser units and the forced fan 124 are turned off.

Coupled in the airflow path immediately downstream of the fan assembly 124 is an arrangement of one or more condenser coils, shown as in Figure 2 as comprising respective primary and secondary condenser coils 125 and 126, over which the drawn-in and filtered intake air passes. These condenser coils condense/extract water from the water vapor in the air flowing through the water extraction section 120. As water condenses onto and drips from the condensation coils 125 and 126 by gravity, it is collected into a bottom water collection pan 104 of the sealed housing 101. The collected water is then funneled or channeled through water output ports 105 and 106 to a water collection supply conduit 107, sealed therewith, for delivery to the storage tank 201 of the water storage/reservoir stage 200.

Located downstream of the condenser coils 125 and 126 is an air input port 127 of a sealed air recirculation duct 128, which contains a recirculation fan 129, and an air output port 131 coupled to the upstream end 121 of the airflow path through the water evaporation and condensation section 120. The air recirculation duct 128 serves to recirculate a portion of the air that has passed through the water extraction components of the water extraction

section 120, so as to provide for extraction of as much water vapor as possible from the intake air before it is returned to the surrounding environment.

To further enhance (increased the efficiency of) the water vapor removal and cooling process, a second evaporator coil 132 and associated de-icing heater element 132H are installed in the exhaust air filtration section 130, immediately downstream of the recirculation duct 128. This additional evaporator coil is operative to further extract water vapor from and cool the air, prior to the processed air being returned through an exhaust port 135 to the surrounding environment. An exhaust air filter 134 is installed in the exhaust air filtration section 130 adjacent to the exhaust port 135, so as to prevent any contaminants that might possibly be present in the processed air from being injected back into the atmosphere. Like intake air filter 115, the exhaust air filter 134 may comprise an electrostatic small particle (electrostatic) air filter.

Figure 4 shows the water storage reservoir stage 200, as comprising an insulated water holding tank 201, such as a commercially available five gallon tank manufactured by Rubbermaid Corp., as a non-limiting example. The water supply conduit 107 from the water extraction section 120, described above, is coupled to water treatment dispenser 220. The water treatment dispenser 220 functions to dispense a measured amount of biological contaminant treatment material, such as bromine or chlorine, as a non-limiting example, that is dissolved in the water, prior to the water being stored in the tank 201.

The water supply conduit 107 is also ported to the auxiliary water supply source 210, which may comprise an exterior water line 211 or a manually controlled water supply 212, so as to allow the use of water other than that extracted from the local ambient by the water extraction stage 100. The ability to process water from an auxiliary source accommodates the situation, for example, where the

water vapor content in the ambient air is insufficient to meet demand. A control valve 213 may be provided in the auxiliary water supply line 211 from the auxiliary water supply source 210, for enabling water from the auxiliary water supply to be controllably supplied to the storage tank 201, when the water level in the storage tank drops to a prescribed low level.

As pointed out above, water usage is monitored by a water level sensor unit 205, containing a high or full water level sensor 231, and a low or minimum water level sensor 232. The high water level sensor 231 is operative to control the operation of the components of the water extraction stage 100, described above, including its fan and compressor units, in accordance with the water level within the water storage tank 201. As long as the water storage tank 201 is less than full, the water extraction stage 100 is operative to draw ambient air into the system, and causing water vapor in the intake air to be extracted, collected and supplied to the reservoir stage 200. However, when the high water level sensor 231 detects a 'full tank' condition, it shuts off driven components (compressors, fan units) of the water extraction stage 100.

The low water level sensor 232 of the water storage tank 201 is operative to control the water flow control pump 225 in the downstream water flow path 230 through the multistage water filtration and delivery stage 300. (As a non-limiting example, the water flow control pump 225 may comprise a 40 psi pump from Flojet.) For this purpose, the low water level sensor 232 provides an output signal that prevents the pump 225 from being turned on, if the water level in the tank 201 drops below a prescribed minimum ('dry') level. This signal is also coupled to the control valve 213 in the water supply line 211 from the auxiliary water supply source 210, and is used to open the valve 213 in the auxiliary exterior water feed line 211, should the water level in the tank 201 drop to an extremely low level.

The multistage water filtration and delivery unit 300 is diagrammatically shown in Figure 5 as comprising a multistage water filtration section 310 installed in the sealed water flow path 230 at the output of the water flow control pump 225. As described above, through a series of progressively finer porosity filters, the water filtration section 310 effectively filters out (absorbs/blocks) substantially all particulates and chemical and biological contaminants from the treated water as its being pumped from the reservoir stage 200 for delivery to one or more water outlet valves 330 of the purified water delivery section 340.

More particularly, in accordance with a first embodiment, an upstream end 311 of the multistage water filtration section 310 includes a first pH adjustment filter 321, such as a calcite filter, which increases the pH of the water and thereby compensates for the very low pH in the water that has been collected and stored in storage tank 201. This pH adjustment thus prevents the processed water from attacking metal components in the water flow path from the storage tank 201.

The next filter is a resin bead, demand-release ionized disinfectant filter 322. Filter 322 sterilizes the water by killing bacteria, viruses and other micro-organisms. Installed downstream of resin bead filter 322 is a third filter 323, which removes large particles of sediment, rust, dirt and sand. For this purpose, a five micron replaceable sediment filter may be employed. This five-micron filter 323 prevents the remaining, downstream filters from becoming clogged by particulate matter in the water.

The water in flow path 230 is next passed through a one-micron carbon block filter 324, that absorbs chemical components, such as halogens (e.g., chlorine, bromine, iodine) and other chemicals, including industrial and agricultural residual chemical compounds. The final filter element of the multistage filter arrangement is a 0.5-

micron carbon block filter 325 installed downstream of the one-micron carbon block filter 324. This filter filters out herbicides, pesticides, industrial and commercial cleaners and other Trihalomethanes (THMs).

In an alternative embodiment of the filter arrangement, rather than install a resin bead filter (filter 322) as the second filter, the resin bead filter is removed, and a 0.2-micron carbon block filter 326 is installed downstream of the 0.5-micron carbon block filter 325. Like resin bead filter 322, this extremely fine 0.2-micron filter 326 sterilizes the water and kills (ninety-nine percent of) all bacteria, viruses and other microorganisms.

Results of analysis of water extracted and purified by the present invention, such as those listed in attached Appendix 1, have shown a remarkable purity of the water, which is understood to far exceed requirements of the U.S. Environmental Protection Agency (EPA). Indeed, tests have shown that purified water provided by the extraction, treatment and filtration system of the present invention is free of ninety-nine percent (99%) of all bacteria, viruses and other microorganisms, herbicides, pesticides, industrial and commercial cleaners and other Trihalomethanes (THMs), and ninety-seven percent (97%) of chemical contaminants, including industrial and agricultural residual chemical compounds.

As water is pumped through the multistage filtration section 310, it is monitored via a flow meter 312, installed in the water flow path 230. Flow meter 312 generates an output signal, which shuts down the water pump 225, and thereby prevents the flow of water through the water flow path 230 to the purified water delivery section 340, when the system has reached a maximum gallon usage (e.g., 1500 gallons), and the water filters require replacement.

As water is pumped through the multistage water filtration section 310 it is supplied directly to the purified water delivery section 340, which provides the purified water on demand by way of output valves 330 of a multitap water dispensing system. As described above, and as diagrammatically illustrated in Figure 5, the purified water delivery section 340 is configured not only to directly deliver purified room temperature water as filtered by the filtration section 310, but contains a water characteristic control unit 350 for controlling at least one characteristic of the water as it is supplied to the user.

The water characteristic control unit 350 contains a plurality of purified water conduits 351, 352, 353, 354 and 355, that are respectively coupled to a mixing valve 371, a water heater 372, a water cooler 373, a direct feed room temperature output valve 334, and a supply valve of an ice-maker 375 of the multitap water dispensing system. Mixing valve 371 is coupled to a flavoring additive supply tank 380, which stores a flavoring additive, such as a flavored soft drink syrup, and to a carbonation tank 390. Mixing valve thus allows the water in conduit 351 to be mixed with additives (e.g., flavoring and/or carbonation), as desired. The output of mixing valve is coupled to a soft drink valve 331. The output of water heater 372 is coupled to a valve 332 for supplying hot water, while the output of water cooler 373 is coupled to a valve 333 for supplying cold water. On request, the dispensing system dispenses hot, cold, room temperature or carbonated purified potable water; via ice-maker 375, it also stores and supplies water in its solid phase (ice). In addition, via mixing valve 371, the dispensing system can also produce a self-generated carbonated and flavored soft drink.

The demand for water is sensed by operation of one of the water output valves 330 of the multitap water dispensing system. This causes a reduction in the water pressure in the water flow path 230, which is sensed by a

low pressure sensor 235. The output of sensor 235 supplies a controlled pump activation signal to the water pump 225, causing the water pump 225 to pump water through the multistage filtration unit 310 to the purified water delivery section 340.

As described above, electrical power for operating the water extraction and purification system of the present invention may be derived from a conventional AC source, such as 110 VAC.

In addition, as diagrammatically illustrated in Figure 6, auxiliary emergency power for operating subsystem water supply components may be supplied by a number of sources. These sources include a commercially available 12 volt direct current wind-driven generator 401, and a commercially available 12 volt direct current photoelectric solar array 403, which are connected via external connection terminals 405 and a switch 407 to a 12 volt direct current storage battery 410.

A DC-AC converter 412 is coupled to storage battery 410 for supplying emergency 110 VAC power. An auxiliary emergency (power outage) battery back-up trickle charge circuit 412 may also be coupled in circuit with the switch 407, to selectively provide a trickle charge to the battery 410. The trickle charger 412 keeps the 12 volt direct current storage battery 410 fully charged. Storage battery 410 can maintain a full charge, so as to enable the water pump and low wattage lighting elements, associated with the output taps of the water dispenser, to be operated, without conventional power. Thus, in the event of a power outage, the auxiliary power supply will at least power those components that will allow the user to be supplied with whatever water is in the water storage tank.

As will be appreciated from the foregoing description, the present invention provides a relatively compact, integrated and sealed purified water supply apparatus that is not only operative to extract, store and purify water from water vapor in ambient air, but prevents entry of

contaminants in the surrounding atmosphere from entering the system. Because the multi-stage ambient air intake filtering section employs a passive (large particle) filter in conjunction with an active (electrostatic small particle) filter, as well as a forced air re-circulation path, the efficiency of the water extraction process is enhanced. In addition, providing an active (electrostatic small particle) filter in the air exhaust section effectively prevents reentry of any unwanted airborne particles into the surrounding atmosphere.

The multistage filtration system provides superior water purification, eliminating ninety nine percent of bacteria, viruses and other micro-organisms, ninety seven percent of industrial and agricultural chemicals, and ninety-nine percent of herbicides, pesticides, solvents and other Trihalomethanes (THMs).

This highly purified water is available to the user in a variety of modes by way of a dispensing unit that provides, stores and dispenses potable drinking water in five different forms which include room temperature, hot, cold, carbonated and solid (ice) and can dispense a carbonated flavored soft drink.

While we have shown and described an embodiment in accordance with the present invention, it is to be understood that the same is not limited thereto but is susceptible to numerous changes and modifications as are known to a person skilled in the art, and we therefore do not wish to be limited to the details shown and described herein, but intend to cover all such changes and modifications as are obvious to one of ordinary skill in the art.

APPENDIX 1 (pp 1-3)

NOTE: "*" The MCL (Maximum Contaminant Level) or an established guideline has been exceeded for this contaminant.

"**" Bacteria results may be invalid due to lack of collection information or because the sample has exceeded the 30-hour holding time.

"ND" This contaminant was not detected at or above our stated detection level.

"NBS" No bacteria submitted.

"P" = PRESENCE "A" = ABSENCE

"EP" = E. COLI PRESENCE "EA" = E. COLI ABSENCE

| Analysis Performed | MCL (mg/1) | Det. Level | Level Detected |
|---|---|---|---|
| Total coliform | P | P | A |
| **Inorganic chemicals - metals:** | | | |
| Aluminum | 0.2 | 0.1 | ND |
| Arsenic | 0.05 | 0.010 | ND |
| Barium | 2 | 0.30 | ND |
| Cadmium | 0.005 | 0.002 | ND |
| Chromium | 0.1 | 0.004 | ND |
| Copper | 1.3 | 0.004 | ND |
| Iron | 0.3 | 0.020 | ND |
| Lead | 0.015 | 0.002 | ND |
| Manganese | 0.05 | 0.004 | ND |
| Mercury | 0.002 | 0.001 | ND |
| Nickel | 0.1 | 0.02 | ND |
| Selenium | 0.05 | 0.002 | ND |
| Silver | 0.1 | 0.002 | ND |
| Sodium | --- | 1.0 | 7 |
| Zinc | 5 | 0.004 | 0.014 |
| **Inorganic chemicals - other, and physical factors:** | | | |
| Alkalinity (Total as CaCO3) | --- | 20.0 | 15 |
| Chloride | 250 | 5.0 | 10 |
| Fluoride | 4 | 0.5 | 1.2 |
| Nitrate as N | 10 | 0.5 | ND |
| Nitrite as N | 1 | 0.5 | ND |
| Sulfate | 500 | 5.0 | ND |
| [illegible] | | [illegible] | [illegible] |

p 1

page 2. Sample code: 8150530

| Analysis performed | MCL (mg/l) | Detection Level | Level Detected |
|---|---|---|---|
| Benzene | 0.005 | 0.001 | ND |
| Vinyl Chloride | 0.002 | 0.001 | ND |
| Carbon Tetrachloride | 0.005 | 0.001 | ND |
| 1,2-Dichloroethane | 0.005 | 0.001 | ND |
| Trichloroethene | 0.005 | 0.001 | ND |
| 1,4-Dichlorobenzene | 0.075 | 0.001 | ND |
| 1,1-Dichloroethene | 0.007 | 0.001 | ND |
| 1,1,1,-Trichloroethane | 0.2 | 0.001 | ND |
| Bromobenzene | --- | 0.002 | ND |
| Bromomethane | --- | 0.002 | ND |
| Chlorobenzene | 0.1 | 0.001 | ND |
| Chloroethane | --- | 0.002 | ND |
| Chloromethane | --- | 0.002 | ND |
| 2-Chlorotoluene | --- | 0.001 | ND |
| 4-Chlorotoluene | --- | 0.001 | ND |
| Dibromochloropropane (DBCP) | --- | 0.001 | ND |
| Dibromomethane | --- | 0.002 | ND |
| 1,2-Dichlorobenzene | 0.6 | 0.001 | ND |
| 1,3-Dichlorobenzene | 0.6 | 0.001 | ND |
| Dichlorodifluoromethane | --- | 0.002 | ND |
| 1,1-Dichloroethane | --- | 0.002 | ND |
| Trans-1,2-Dichloroethene | 0.1 | 0.002 | ND |
| cis-1,2-Dichloroethene | 0.07 | 0.002 | ND |
| Dichloromethane | 0.005 | 0.002 | ND |
| 1,2-Dichloropropane | 0.005 | 0.002 | ND |
| trans-1,3-Dichloropropene | --- | 0.002 | ND |
| 1,3-Dichloropropene | --- | 0.002 | ND |
| 2,2-Dichloropropane | --- | 0.002 | ND |
| 1,1-Dichloropropene | --- | 0.002 | ND |
| 1,3-Dichloropropane | --- | 0.002 | ND |
| Ethylbenzene | 0.7 | 0.001 | ND |
| Ethylenedibromide (EDB) | --- | 0.001 | ND |
| Styrene | 0.1 | 0.001 | ND |
| 1,1,1,2-Tetrachloroethane | --- | 0.002 | ND |
| 1,1,2,2-Tetrachloroethane | --- | 0.002 | ND |
| Tetrachloroethene (PCE) | 0.005 | 0.002 | ND |
| 1,2,4-Trichlorobenzene | --- | 0.002 | ND |
| 1,2,3-Trichlorobenzene | --- | 0.002 | ND |
| 1,1,2-Trichloroethane | 0.005 | 0.002 | ND |
| Trichlorofluoromethane | --- | 0.002 | ND |
| 1,2,3-Trichloropropane | --- | 0.002 | ND |
| Toluene | 1 | 0.001 | ND |
| Xylene | 10 | 0.001 | ND |
| **Organic chemicals - pesticides, herbicides and PCBs** | | | |
| Alachlor | 0.002 | 0.001 | ND |
| Atrazine | 0.003 | 0.002 | ND |
| Chlordane | 0.002 | 0.001 | ND |
| Aldrin | --- | 0.002 | ND |
| Dichloran | --- | 0.002 | ND |
| Dieldrin | --- | 0.001 | ND |
| Endrin | 0.002 | 0.0001 | ND |
| Heptachlor | 0.0004 | 0.0004 | ND |
| Heptachlor Epoxide | 0.0002 | 0.0001 | ND |
| Hexachlorobenzene | 0.001 | 0.0005 | ND |
| Hexachlorocyclopentadiene | 0.05 | 0.001 | ND |
| Lindane | 0.0002 | 0.0002 | ND |
| Methoxychlor | 0.04 | 0.002 | ND |
| PCBs | 0.0005 | 0.0005 | ND |
| [illegible] | --- | [illegible] | ND |

p2

| | | | |
|---|---|---|---|
| Hardness (suggested limit = 100) | | 10.0 | 15 |
| pH (Standard Units) | 6.5-8.5 | --- | 7.6 |
| Total Dissolved Solids | 500 | 20.0 | 33 |
| Turbidity (Turbidity Units) | 1.0 | 0.1 | 0.1 |
| **Organic chemicals - trihalomethanes:** | | | |
| Bromoform | 0.1 | 0.004 | ND |
| Bromodichloromethane | 0.1 | 0.002 | ND |
| Chloroform | 0.1 | 0.002 | ND |
| Dibromochloromethane | 0.1 | 0.004 | ND |
| Total THMs (sum of four above) | 0.1 | 0.002 | ND |

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WHAT IS CLAIMED

1. A purified water supply apparatus comprising:

a water extraction stage having an intake air filter section, said intake air filter section including an air inlet port, and containing at least one intake air filter through which intake air passes, a water extraction section coupled in an air flow path with said intake air filter section, and containing at least water extraction element that is operative to extract water vapor present in air that has passed through said intake air filter section, and an exhaust air filter section coupled in an air flow path with said water collection section, said exhaust air filter section including an exhaust air filter through which air exiting said water collection section is exhausted;

a water storage reservoir coupled in sealed communication with and being operative to store water supplied thereto from said water extraction section;

a multistage water filtration section coupled in sealed communication with said water storage reservoir, and containing multiple water filters installed in a sealed water flow path from said water storage reservoir and being operative to filter particulates and chemical and biological contaminants from water passing therethrough from said water storage reservoir; and

at least one water outlet port coupled to said multistage water filtration section.

2. A purified water supply apparatus according to claim 1, wherein said water extraction section contains a plurality of water extraction elements that are operative to extract water vapor present in air that has passed through said intake air filter section, and a sealed air recirculation path having an input port coupled downstream of one of said water extraction elements and an output port coupled upstream of another of said water extraction elements and being operative to cause air that has passed

through water extraction elements of said water extraction section to be recirculated back through said water extraction elements.

3. A purified water supply apparatus according to claim 1, further including a forced air mechanism which is operative to force air through said intake air filter section, said water extraction section and said air exhaust filter section.

4. A purified water supply apparatus according to claim 3, wherein said forced air mechanism is operative to force air through said air recirculation path.

5. A purified water supply apparatus according to claim 3, wherein said water storage reservoir includes a water level sensor that controls the operation of said forced air mechanism in accordance with the quantity of water stored by said water storage reservoir.

6. A purified water supply apparatus according to claim 5, further including a water flow pump coupled with said water flow path from said water storage reservoir and being controllably operative to pump water through said water flow path for delivery by said at least one water outlet port, and wherein said water level sensor is operative to control the operation of said water flow pump in accordance with the volume of water in said water storage reservoir.

7. A purified water supply apparatus according to claim 6, further including an auxiliary water supply port coupled to said water storage reservoir and being operative to supply water thereto from a source other than said water extraction section in accordance with an output of said water level sensor.

8. A purified water supply apparatus according to claim 1, wherein said water extraction section contains a first evaporator coil unit installed at a relatively upstream portion of said water extraction section, and a second evaporator coil unit installed at a relatively downstream portion of said water extraction section.

9. A purified water supply apparatus according to claim 8, wherein said water extraction section further includes at least one condenser coil coupled in an air flow path passed said first and second evaporator coils.

10. A purified water supply apparatus according to claim 9, wherein said input port of said air recirculation path is coupled downstream of said at least one condenser coil element and said output port of said air recirculation path is coupled upstream of said first evaporator coil.

11. A purified water supply apparatus according to claim 10, further including a forced air mechanism, which is operative to force air through said intake air filter section, said water extraction section and said air exhaust filter section, and also through said air recirculation path.

12. A purified water supply apparatus according to claim 1, wherein said multistage water filtration section includes a series of successive filtration elements, including at least one submicron filtration element, installed in said water flow path from said water storage reservoir.

13. A purified water supply apparatus according to claim 11, wherein one of said filtration elements contains resin bead filtration material.

14. A purified water supply apparatus according to claim 1, wherein said multistage water filtration section includes a sequential arrangement of a pH adjustment filter, a sediment filter, a first absorption filter, downstream of said sediment filter, a second absorption filter downstream of and having a finer porosity than said first absorption filter, said first and second absorption filters being operative to block chemical contaminants, and a biological contaminant extraction filter downstream of said second absorption filter and being operative to block biological contaminants.

15. A purified water supply apparatus according to claim 1, wherein said multistage water filtration section includes a sequential arrangement of a pH adjustment filter, a biological contaminant extraction filter, a sediment filter, a first absorption filter, a second absorption filter downstream of and having a finer porosity than said first absorption filter, said first and second absorption filters being operative to block chemical contaminants.

16. A purified water supply apparatus according to claim 12, further including a water treatment dispenser coupled with said water storage reservoir and being operative to dispense biological contaminant treatment material into water stored in said water storage reservoir.

17. A purified water supply apparatus according to claim 1, further including an auxiliary water supply port coupled to said water storage reservoir and being operative to supply water thereto from a source other than said water extraction section.

18. A purified water supply apparatus according to claim 1, further including a water characteristic control unit, coupled with said multistage water filtration section and said at least one water outlet port, and being operative to control at least one characteristic of water that has been filtered by said multistage water filtration section.

19. A purified water supply apparatus according to claim 18, wherein said water characteristic control unit is operative to control at least one of water temperature and introduction of a substance into water that has been filtered by said multistage water filtration section.

20. A purified water supply apparatus according to claim 1, further including a water flow pump coupled with said water flow path from said water storage reservoir and being controllably operative to pump water through said water flow path and through said multistage water filtration section for delivery by said at least one water

outlet port, and including a water flow meter which is operative to controllably disable the operation of said water flow pump in response to a prescribed volume of water flow through said multistage water filtration section.

21. A purified water supply apparatus comprising:

a sealed water extraction stage that is operative to draw in, filter and extract water vapor from ambient air, and to filter processed air that has been dehumidified by water extraction before being returned to the surrounding environment;

a water storage stage, coupled in sealed fluid communication with said water extraction stage and being operative to chemically treat and store water that has been condensed out of the filtered ambient air by said water extraction stage; and

a water filtration stage installed in a sealed water flow path through a water flow control mechanism that is coupled in said sealed water flow path with said water storage stage, said water filtration stage containing a plurality of filters that are effective to filter out particulates, dissolved chemicals and biological contaminants from water pumped by a water pump from said water storage stage for delivery to one or more water outlet ports.

22. A purified water supply apparatus according to claim 21, wherein said water storage stage includes a sealed water storage reservoir, said sealed water storage reservoir being coupled to an auxiliary water supply, and including a control valve in a water supply line from the auxiliary water supply source for enabling water to be automatically supplied to said water storage reservoir in response to the quantity of stored in said water storage reservoir dropping to a prescribed low level.

23. A purified water supply apparatus according to claim 21, wherein said water extraction stage includes a forced air unit, that is controllably operative to draw ambient air through an intake air filter section that

filters the air of unwanted air-borne particles, and through a water evaporation and condensation section, containing an evaporator and condenser coil arrangement that condenses water from water vapor in the filtered intake air, and cools processed air, prior to its being returned to the surrounding environment.

24. A purified water supply apparatus according to claim 23, wherein said forced air unit and said water pump are controlled in accordance with the water quantity in said water storage reservoir.

25. A purified water supply apparatus according to claim 23, wherein said water extraction stage includes an air recirculation path coupled to recirculate air processed through said water extraction stage, so as to provide for enhanced cooling of the air and removal of water vapor from the filtered air, before the air is returned to the surrounding environment.

26. A purified water supply apparatus according to claim 21, further including a flow meter which monitors the flow of water pumped through said multistage filtration section, and being operative to generates an output signal that shuts down said water pump, and thereby prevents the flow of water, in response to a water usage associated with the need to replace said water filters.

27. A purified water supply apparatus according to claim 21, further including a purified water delivery section that supplies purified water on demand by way of output valves of a multitap water dispensing system.

28. A purified water supply apparatus according to claim 21, wherein electrical power for operating at least one component of said purified water supply apparatus is derivable from a direct current storage battery that is selectively coupled to at least one of a direct current wind-driven generator, a direct current photoelectric solar array, and an auxiliary battery back-up trickle charger.

29. A purified water supply apparatus according to claim 21, further including a filtered water dispensing unit coupled to said water filtration stage that provides, stores and dispenses potable drinking water in different forms which include at least one of room temperature, hot, cold, carbonated and solid (ice).

30. A method of supplying water comprising the steps of:

(a) filtering and dehumidifying ambient air in a sealed housing, so as to extract water therefrom and return cooled and filtered ambient air to the surrounding environment;

(b) chemically treating and storing, in a sealed water storage reservoir, water that has been extracted in step (a) and supplied to said reservoir by way of a water flow path that is sealed from said surrounding environment; and

(c) passing water that has been treated and stored in step (b) through a plurality of water filters that filter out particulates, dissolved chemicals and biological contaminants from said water, and delivering purified water to one or more water outlet ports.

31. A method according to claim 30, where step (b) further includes treating and storing water in said water storage reservoir, from an auxiliary water supply, in response to the quantity of stored in said water storage reservoir dropping to a prescribed low level.

32. A method according to claim 30, wherein step (a) comprises drawing said ambient air into said sealed housing through a first air filter that filters said ambient air of unwanted air-borne particles, and through a water evaporator and condenser coil arrangement installed in said sealed housing that condenses water from water vapor in air filtered by said first air filter, and cools the air, prior to its being returned to the surrounding environment through a second air filter.

33. A method according to claim 32, wherein said step (a) and step (c) are controlled in accordance with the water quantity in said water storage reservoir.

34. A method according to claim 32, wherein step (a) further includes recirculating air processed through said and condenser coil arrangement, so as to provide for enhanced cooling of the air and removal of water vapor from the filtered air, before the air is returned to the surrounding environment.

35. A method according to claim 30, wherein step (c) further includes monitoring the flow of water passing through said plurality of water filters and interrupting the flow of water therethrough, in response to a water usage associated with the need to replace said plurality of water filters.

36. A method according to claim 30, wherein step (c) includes delivering said purified water to said one or more water outlet ports by means of a purified water delivery stage that supplies purified water on demand by way of output valves.

37. A method according to claim 30, wherein step (c) includes dispenses purified water in different forms, which include at least one of room temperature, hot, cold, carbonated and solid (ice).

38. A method according to claim 30, wherein steps (a) and (c) are performed by electrically driven components, and wherein electrical power for operating at least one of said electrically driven components is derivable from a direct current storage battery that is selectively coupled to at least one of a direct current wind-driven generator, a direct current photoelectric solar array, and an auxiliary battery back-up trickle charger.

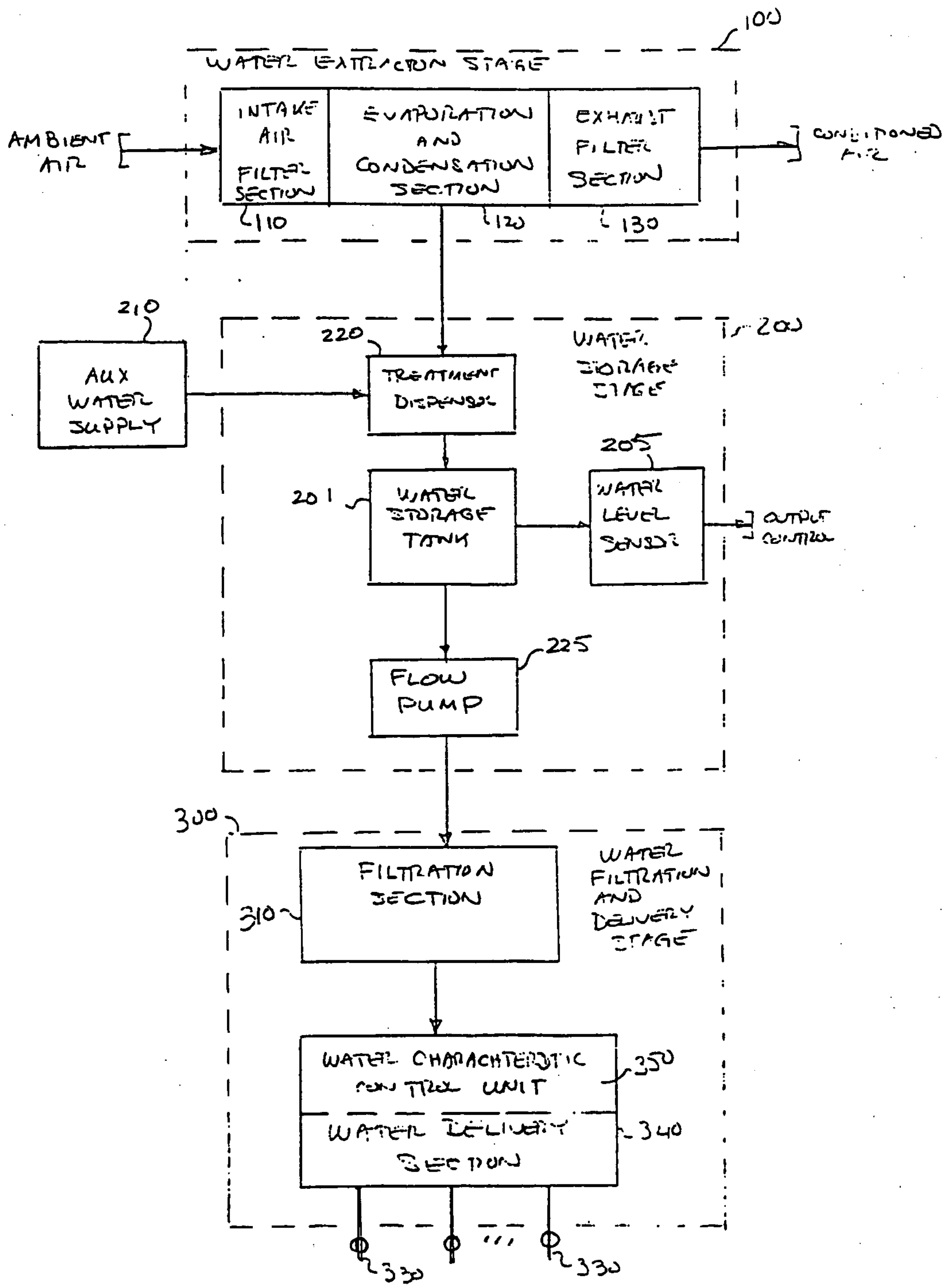
100
WATER EXTRACTION STAGE
AMBIENT AIR
INTAKE AIR FILTER SECTION
EVAPORATION AND CONDENSATION SECTION
EXHAUST FILTER SECTION
CONDITIONED AIR
110
120
130
210
AUX WATER SUPPLY
220
TREATMENT DISPENSER
WATER STORAGE STAGE
200
205
201
WATER STORAGE TANK
WATER LEVEL SENSOR
OUTPUT CONTROL
225
FLOW PUMP
300
FILTRATION SECTION
WATER FILTRATION AND DELIVERY STAGE
310
WATER CHARACTERISTIC CONTROL UNIT
350
WATER DELIVERY SECTION
340
330
330

FIG. 1

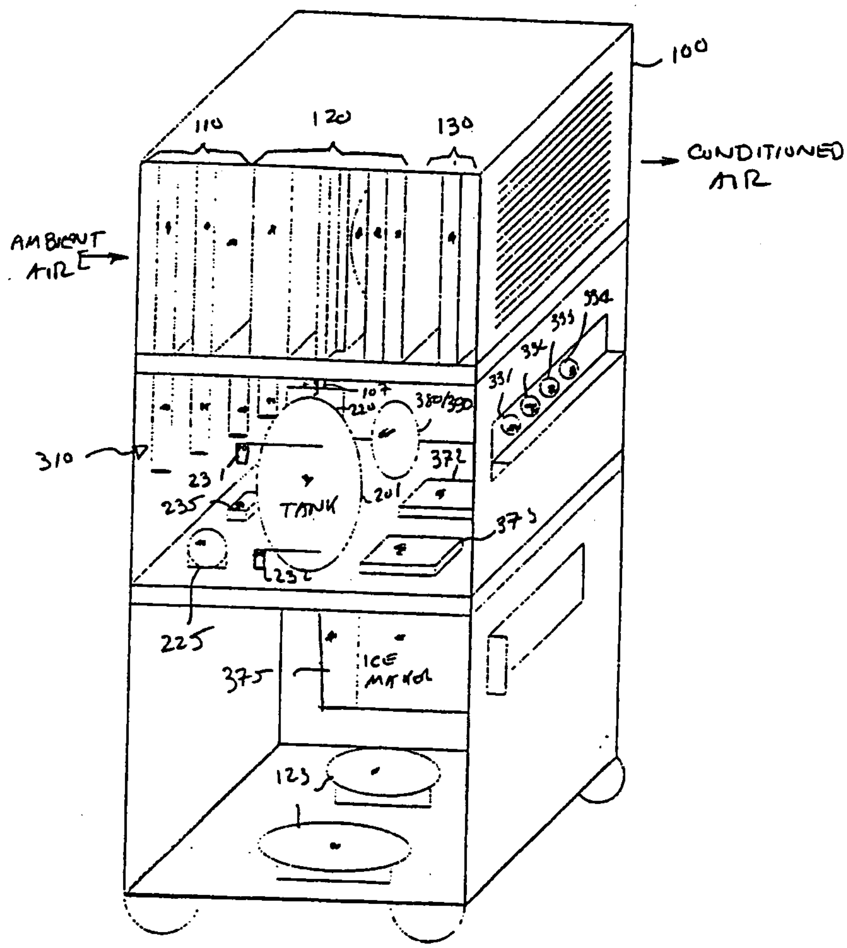
100
110
120
130
CONDITIONED AIR
AMBIENT AIR
107
220
380/390
331
332
333
334
310
231
235
TANK
201
372
373
225
232
375
ICE MAKER
123

FIG. 2

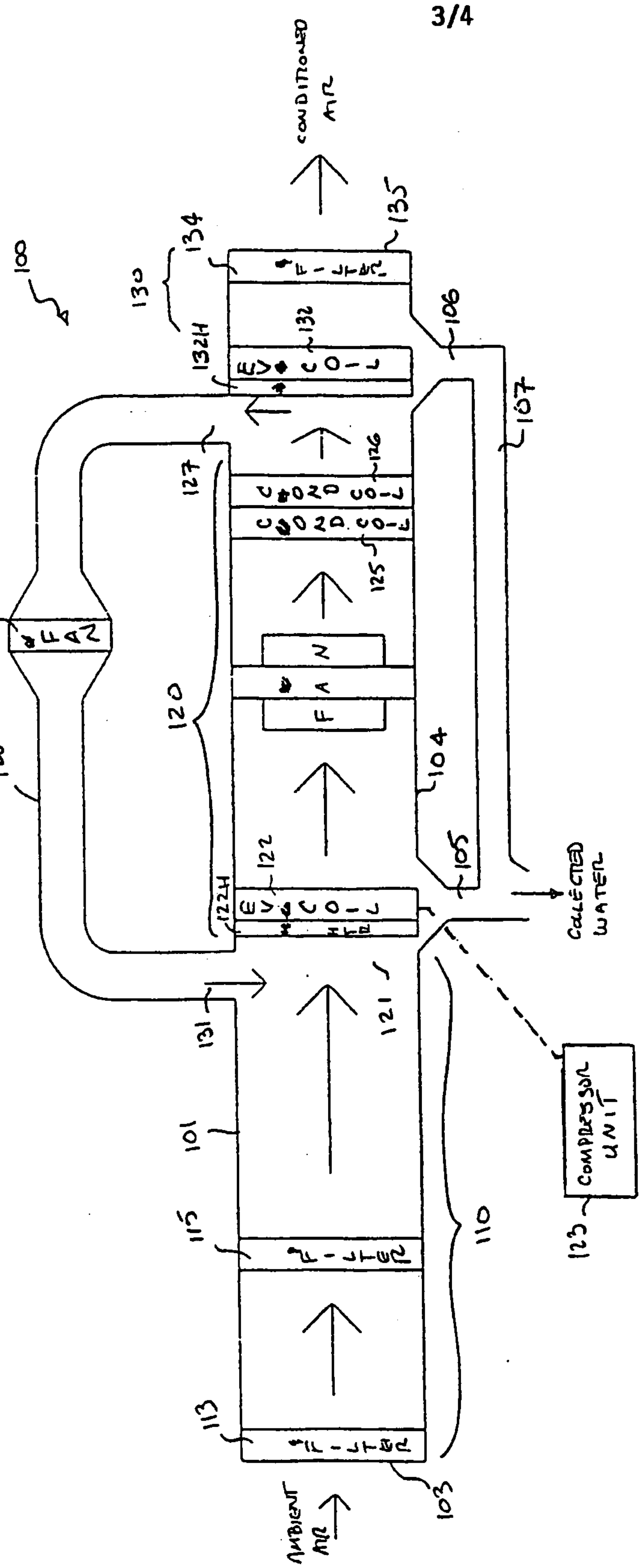
CONDITIONED AIR
100
130
134
135
132H
132
EV COIL
106
107
127
126
COND COIL
COND COIL
125
129
FAN
120
FAN
104
128
105
122
122H
EV COIL
HTR
COLLECTED WATER
121
131
101
COMPRESSOR UNIT
123
115
FILTER
110
113
FILTER
103
AMBIENT AIR

FIG. 3

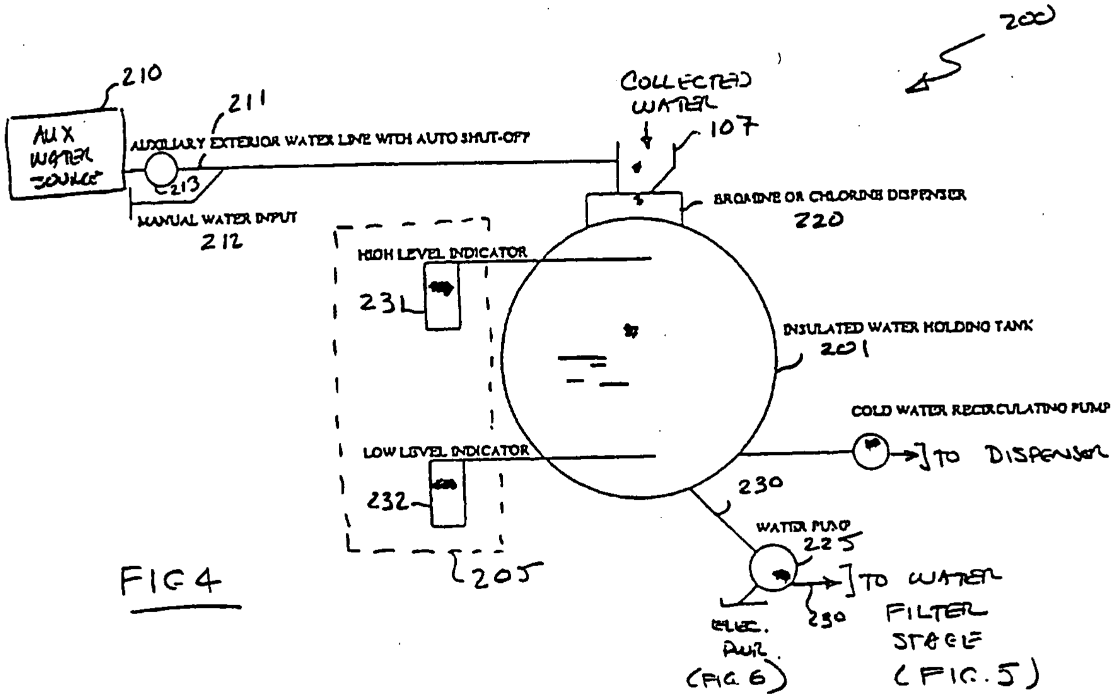
200
210
AUX WATER SOURCE
211
AUXILIARY EXTERIOR WATER LINE WITH AUTO SHUT-OFF
213
MANUAL WATER INPUT
212
COLLECTED WATER
107
BROMINE OR CHLORINE DISPENSER
220
HIGH LEVEL INDICATOR
231
INSULATED WATER HOLDING TANK
201
COLD WATER RECIRCULATING PUMP
TO DISPENSER
LOW LEVEL INDICATOR
232
230
205
WATER PUMP
225
TO WATER FILTER STAGE (FIG. 5)
ELEC. PWR. (FIG 6)
230

FIG 4

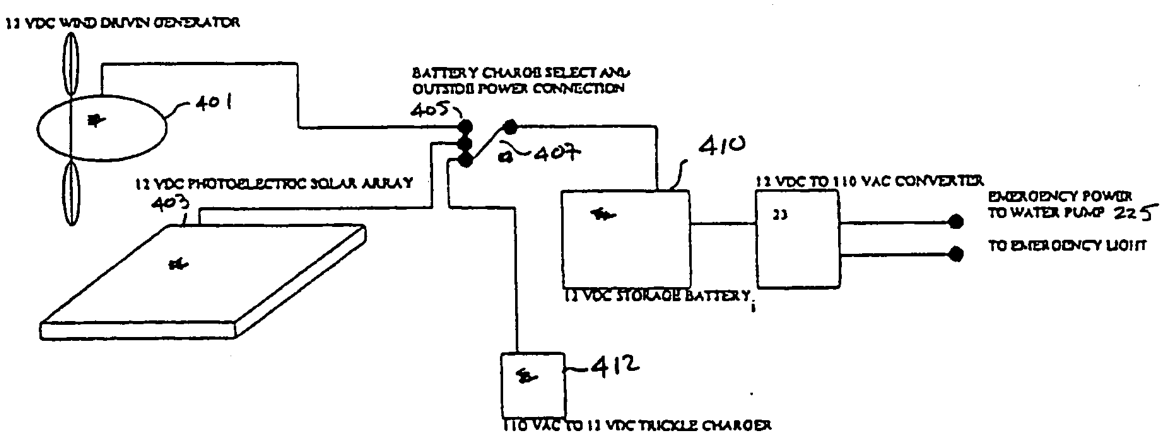
12 VDC WIND DRIVEN GENERATOR
401
BATTERY CHARGE SELECT AND OUTSIDE POWER CONNECTION
405
407
410
12 VDC PHOTOELECTRIC SOLAR ARRAY
403
12 VDC TO 110 VAC CONVERTER
EMERGENCY POWER TO WATER PUMP 225
TO EMERGENCY LIGHT
12 VDC STORAGE BATTERY
412
110 VAC TO 12 VDC TRICKLE CHARGER

FIG 6

# INTERNATIONAL SEARCH REPORT

International application No.
PCT/US97/16682

**A. CLASSIFICATION OF SUBJECT MATTER**

IPC(6) :F25D 17/06
US CL :210/104, 149, 203, 257.1, 266, 284, 744, 753; 62/92, 150
According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 210/86, 97, 104, 143, 149, 203, 206, 257.1, 266, 284, 739, 744, 749, 753; 62/92, 150

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| Y,E | US 5,669,221 A (LE BLEU et al.) 23 September 1997, col. 7, line57-col. 8, line 42. | 1-7,12,21, 22,30,31, 36-38 |
| Y | US 5,517,829 A (MICHAEL) 21 May 1996, col. 3, line 48-col. 6, line 16. | 1-7,12,21, 22,30,31, 36-38 |
| A | US 4,872,319 A (TONGU) 10 October 1989, entire document. | 1-38 |
| A | US 5,203,989 A (REIDY) 20 April 1993, entire document. | 1-38 |

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 03 DECEMBER 1997 | 02 FEB 1998 |

| Name and mailing address of the ISA/US | Authorized officer |
|---|---|
| Commissioner of Patents and Trademarks<br>Box PCT<br>Washington, D.C. 20231 | STANLEY S. SILVERMAN |
| Facsimile No. (703) 305-3230 | Telephone No. (703) 308-3837 |